Available online at www.elixirpublishers.com (Elixir International Journal)

Electrical Engineering

Elixir Elec. Engg. 38 (2011) 4235-4238

ISSN: 2229-712X

Design of remote EB metering system with Arm controller

R.Ramachandran[1,*] and J. Thomas Joseph Prakash[2]

[1]Department of Applied Electronics-Physics (Interdisciplinary), Manonmaniam Sundaranr University, Thirunelveli, TamilNadu, India
[2]Department of Physics, H.H. The Rajah's College, Pudukkottai – 622001, TamilNadu, India.

ARTICLE INFO

Article history:
Received: 5 July 2011;
Received in revised form:
23 August 2011;
Accepted: 28 August 2011;

Keywords
ARM controller,
Remote metering system,
Automatic EB billing,
Microcontroller,
LPC2148,
GSM 3000 modem.

ABSTRACT

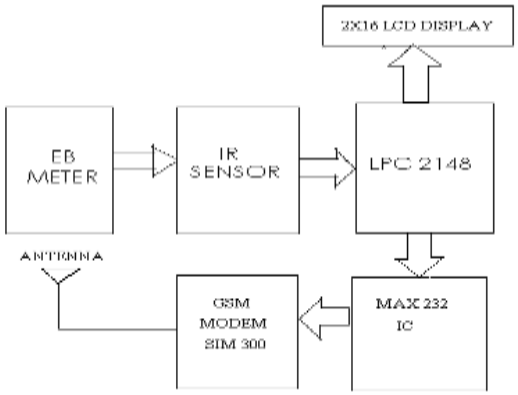
This paper emphasis the automatic remote EB metering system using the existing GSM technology to reduce the human intervention, in order to save invaluable man time and to reduce the cost. This is fast, accurate and time saving. Though both analog and digital meters are widely used, in this work the existing analog reading meter with additional circuitry of IR sensor is used for demonstration. Nowadays GSM network is not only used mere mobile conversation, its applications are countless. At the end of every month or the date programmed in the controller, the actual readings (units consumed) will be sent to the consumer by the SMS (Short Messaging Services). ARM microcontroller has been programmed to govern all these works. A prototype system has been developed for experimentation.

Introduction

The paper aims at instantaneous transmission of the quantity of power consumed as measured by the energy meter and also sensing any misusage by the consumer. The implementation of these automated systems (communication and security alert) is realized using ARM controller[1] with GSM technology[2]. In EB meters there are two types, analog meters and digital meters. The analog meters are mostly used in olden days and even it is used in many countries. These meter readings are calculated under the basis of the number of rotation made by the rotating disc. The digital meter is commonly used EB meters now a day. This meter works on the basis of the flash made by the LED and according to that the reading are calculated.

On approach of EB metering system is that enumerator has to go every home or industry with paper and pen to note the readings or should have any handheld devices. This approach seems the wastage of invaluable human time and it is tiresome. In [3], getting meter readings, using PSTN networks have been introduced. In another approach of remote metering system[4],[5],[6], wireless networks have been proposed. Some commercial remote metering system products use the internet for the data transmission. The MainsTalk[7] and Archnet[8] use power line carrier(PLC) technology to remove extra wiring for internet connection with the meter. In [9], Bluetooth technology has been proposed for remote metering.

In our idea we are using ARM micro controllers namely LPC2148 in both receiving and transmitting part and also in detecting faults and controlling security systems. The power measured by the energy meter is sensed using infrared sensor[10],[19] and given to the microcontroller for manipulation and storage purpose. The Wireless transmission is carried out using the GSM technology. The microcontroller in the receiver part (EB meter) had been programmed to sense/store the status of the IR sensor in order to count the rotation of the disc which in turn used to calculate the kilowatt-hour[11]. Whenever the date and time programmed comes, the ARM controller latch the number of units calculated for the month and send this information to GSM module namely SIM 300 [12] and later same will be communicated to the consumer's mobile through SMS. Remote meter can be used in residential apartments and industrial consumer where bulk energy consumed. The figure (1) shows block diagram of the modules used in transmission and reception.



Transmission Module

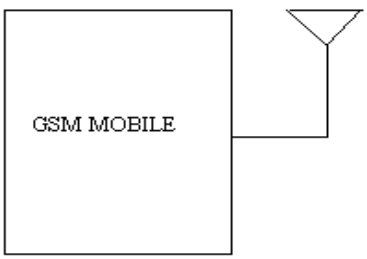


Figure (1) Receiver Module

Circuit Description:

The major hardware modules used in this work are 1. EB meter, 2. IR sensor, 3. GSM modem (SIM 300), 4. LCD, 5.

Tele:
E-mail addresses: ramachandran71@yahoo.com

Limit switch, 6. LPC 2148 Arm microcontroller, 7. MAX 232 serial port device, 8. Power supply and 9. GSM mobile.

Description of existing EB meter:

Energy[13],[14] is the total power delivered or consumed over a time interval. Energy consumed is measured with the help of energy meter. The induction type of energy meter[15] is used universally for measuring energy consumed in domestic and in industry purpose.

Ferraris meter:

Electricity is measured in kilowatts-hours. The Ferraris meter[16] is also referred to as an induction meter. Ferraris meters are in wide use due to their simplicity of design and low cost for mass production. The single-phase, watt-hour meters found in many homes are usually of this type. The meter has an electromagnet, called the stator, which consist of voltage coil and current coil. These coils are connected to the incoming line and react electro magnetically in proportion to the line voltage and current, or power. Meter readings may be displayed on dials, recorded in graphic form on charts[17], or transmitted electronically to digital read-out devices[18]. There are different ways to measure the rotation of the disc.

The old mechanical way is to let the disc drive a gear train connected to a series of dials that indicates the kilowatt-hour (kWh) reading. Sequence of the switching will determine the direction of the rotation. An alternative is to use Tran missive sensor, in which a slot on the disc will replace the dark tape to actuate the sensors. In this paper we have designed a prototype model with energy meter which is having a rotating disc mounted on a AC motor.

IR sensor:

An IR sensor capable of detecting a contrast between adjacent surfaces, such as difference in color, roughness, or magnetic properties The simplest would be detecting a difference in color, for example black and white surfaces. Using simple optoelectronics, such as infrared photo-transistors, color contrast can easily be detected. Infrared emitter/detectors or photo-transistors are inexpensive and are easy to interface with a microcontroller.

Theory of the operation[19] is simple concept, consider the basic effects of light and what happens when it shines on a black or white surface. When light shines on a white surface, most of the incoming light is reflected away from the surface. In contrast, most of the incoming light is absorbed if the surface is black. Therefore, by shining light on a surface and having a sensor to detect the amount of light that is reflected, a contrast between black and white surfaces can be detected. Figure (2) shows an illustration of the basics just covered.

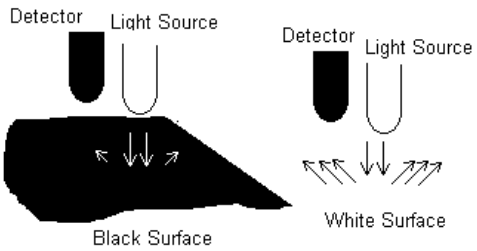


Figure 2. Light reflecting off a white and black surface.

GSM modem:

GSM is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. There are five different cell sizes in a GSM network—macro, micro, Pico, femto and umbrella cells. One of the key features of GSM is the Subscriber Identity Module, commonly known as a SIM card[20]. The SIM is a detachable smart card containing the user's subscription information and phone book. This allows the user to retain his or her information after switching handsets.

Figure (3) shows a GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone.

When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

Figure 3. SIM 300 GSM modem

A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities.

A GSM modem exposes an interface that allows applications such as Now SMS to send and receive messages over the modem interface. The mobile operator charges for this message sending and receiving as if it was performed directly on a mobile phone. To perform these tasks, a GSM modem must support an “extended AT command set” for sending/receiving SMS messages

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card [21] slots of a laptop computer.

Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate.

In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, one can do things like:

- Reading, writing and deleting SMS messages.
- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.

The number of SMS messages that can be processed by a GSM modem per minute is very low -- only about six to ten SMS messages per minute.

AT commands are instructions used to control a modem. AT is the abbreviation of ATtention. Every command line starts with "AT" or "at". That's why modem commands are called AT commands. Many of the commands that are used to control wired dial-up modems, such as ATD (Dial), ATA (Answer), ATH (Hook control) and ATO (Return to online data state), are also supported by GSM/GPRS modems and mobile phones.

Features of LPC 2148 ARM microcontroller:

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and a unique accelerator architecture enable 32-bit code execution at the maximum clock rate. LPC2141/42/44/46/48 are ideal for the applications where miniaturization is a key requirement. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and other applications.

Working Principle:

An IR Sensor is fixed across the EB meter armature and it is connected to the port of the Arm controller. A small black trap is placed in the armature of the EB meter for counting the rotation of the meter. IR sensor is consists of IR LED and phototransistor. IR LED is a transmitter and phototransistor is a receiver. Normally the output of the IR sensor is in static high, whenever the black trap crosses the IR sensor, a static low signal is provided to the microcontroller and microcontroller assumes the pulse as a count or unit.

Here the LCD is connected at the port 1 and used to display the units of the meter and the date. GSM modem is connected with the serial communication pin of the microcontroller. The TX and RX pin of the GSM modem connected to the arm controller for the serial communication. MAX 232 IC is used for establishing the serial communication between the controller and the modem. An ALP has been written for counting the EB meter reading for 30 days and to send the message to the consumer at the end of the month. In this project two switches are used to feed the EB count and date manually. When the microcontroller read the date as 30th of the month, it will communicate with GSM modem for sending the SMS using AT commands. GSM modem has a slot for SIM card at the backside of the modem SIM card number is stored in microcontroller memory to send the SMS. The message displays the user name, amount of unit consumed and total bill amount. Here limit switch is used for security purpose. If the user opens the EB box, the microcontroller will block the all operation and send the alert SMS to the electricity board. The operation will resumes after the EB person inspects the total box and instead of password protection, reset button is used to switch on the operation

At the receiver end, a mobile is used for receiving the SMS from the GSM modem which is connected in the EB meter. The receiver mobile inbuilt with GSM module, so no need for another GSM modem in receiver end The consumer will receives the SMS with corresponding billing amount with account number. After the completion of one month, the microcontroller starts to reads the data from the EB meter for the consecutive months.

Experiment and Analysis:

We have developed the prototype system in our lab, and several experiments have been conducted. We have developed one metering system at the receiver end, and programmed the ARM controller to latch the EB meter readings for every unit. A specific register was used to hold the units consumed and later this data sent to the GSM modem with appropriate AT commands for every 30 days. GSM modem SIM 300 sent SMS to the consumer mobile with the number of units consumed. The delivery acknowledgement was monitored. In our experiment, 97% SMS was received successfully in one attempt. If failure, due to switch off and un coverage area, 3% was achieved in second and third attempt. Figure (4) shows a graph plot of the response time of the acknowledgement signal.

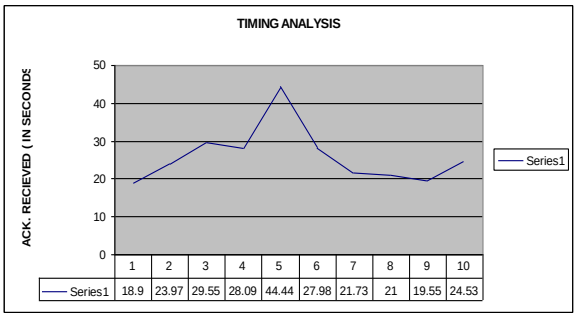


Figure (4)

Conclusion:

In this paper, EB metering system with the control of ARM controller is proposed, consumption units intimated to the consumer through SMS. The various functional units of the system were described. We have received the expected experimental results. Further this work can be continued, and billing could be done on the internet by developing the software module. In order to get the faster data General Packet Radio Service (GPRS) modem could be used.

References

1]www.nxp.com/documents/data_sheet/LPC2141_42_44_46_48 .pdf
[2] http://en.wikipedia.org/wiki/GSM
[3] Embedtronics, http://www.embetronics.com, 2005
[4] L.Cao, j. Tian asnd D. Zhang, "Networked Remote Meter Reading System based on wireless Communication Technology", proc. Of IEEE International conference on Information Acquisition, China August 2006
[5] L.Hong and L. Ning. "Design and Implementation of Remote Intelligent Management System for City Energy Resources based on Wireless Network", Study of computer application, no 12,pp.237-239, 2004.
[6] C.Yin-Kang, L.Xiang-yang and X. Jing. "The Hardware Design of Concentrator for wireless Intilligent Meter Reading System", Element and IC, no. 1, pp. 37 -39, 2005
[7] Energy controls:http://www.energycontrols.org. 2007
[8] Archnet, http://www.archnetco.copm/, 2007
[9] X.Zhaoyin and H.Shiyong, "Automatic Remote Meter Reading System using Bluetooth", Journal of Transducer Technology, vol.23, no7,pp. 68-70,2004
[10] Infrared Detectors, Second Edition by Antonio Rogalski
[11] Textbook of Electrical Technology B.L. Theraja , A.K. Theraja. Hardcover: 2104 pages; Publisher: S Chand & Co Ltd.

[12] http://www.amp-tronics.com/index.php/products/sensors-modules/sim300/
[13] Croft, Terrell; Summers, Wilford I. (1987). American Electricans' Handbook (Eleventh Edition ed.). New York: McGraw Hill.
[14] M. Arumugam & N. PremKumar, "Electric Circuit Theory", Khanna Publishers, New Delhi, 1991.
[15] http://en.wikipedia.org/wiki/Electricity_meter
[16] Transforming the Ferraris disc meter into a key element in an automated meter reading system, Phillips, M.E. Adams, B.J. GEC Meters Ltd.
[17] A Course In Electrical And Electronic Measurements And Instrumentation (Paperback) by Sawhney A K Publisher: Dhanpat Rai & Co. (2005) Details of Book.
[18] http://en.wikipedia.org/wiki/Display_device
[19] Infrared Detectors and Systems (Wiley Series in... by E. L. Dereniak).
[20] http://en.wikipedia.org/wiki/Subscriber_Identity_Module.
[21] http://www.amtron.com